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ABSTRACT

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Interaction of Learner Control and Student Aptitudes

Wayne C. Wilcox

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Presented at the Annual Meeting of the
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Abstract

Fourteen studies were reviewed whose findings indicate that learner control of certain presentation characteristics interacts with certain learner characteristics. Thus, learner control is not a panacea for accomodating individual differences. Instead, some kinds of individual differences probably should be taken into account by teachers and instructional systems as they decide what learner control of presentation characteristics students are given.

Interaction of Learner Control and Student Aptitudes

Two categories of variables which influence student learning are learner and presentation characteristics. Learner characteristics are qualities which may be used to distinguish one learner from another learner. Cognitive abilities and styles are examples of learner characteristics. Presentation characteristics are qualities which may be used to distinguish one piece of instruction from another piece of instruction. Examples of presentation characteristics include rate, difficulty level, mode (e.g., visual or verbal), form (e.g., generalities or instances), and sequence.

A growing number of research studies are finding evidence of particular interactions between learner and presentation characteristics. In other words, not all sets of presentation characteristics are equally well suited for all sets of learner characteristics. Thus, how to appropriately match learner and presentation characteristics should be an important concern of teachers and instructional developers.

Allowing students to select presentation characteristics of the instruction they receive is one way of matching learner and presentation characteristics. Such a learner directed approach assumes that students are good instructional decision makers. If this assumption were correct, experimental treatment groups in which specified presentation characteristics are learner controlled would be expected to perform better than treatment groups in which presentation characteristics are fixed. However, this predicted outcome has not been observed in the learner control research that Dr. M. David Merrill, I, and others have conducted over the past two years.

Perhaps it would be more fruitful to view learner control of

presentation characteristics not only as a method of individualizing instruction, but also as a factor which itself interacts with learner characteristics. Although some kinds of learners may benefit by being able to control presentation characteristics, other kinds of learners may benefit by having presentation characteristics determined for them. This paper will briefly review several studies whose results indicate that learner control of certain presentation characteristics interacts with certain learner characteristics.

Interactions of Learner Control and Ability

First we will consider seven studies dealing with the interaction between learner control of presentation characteristics and ability. Five of these studies found that greater learner control produced a shallower slope of performance on amount of ability than lesser learner control. The other two studies found that greater learner control produced a steeper slope of performance on amount of ability.

Shallower Slopes Produced By Greater Learner Control

Roebuck (1970) pretested fifty-three Nigerian secondary students on their knowledge of mass, weight, and density. These physics topics then were taught to some of the students via a programmed text that permitted self-pacing of the instruction. The remaining students were given the same instruction through a series of group lectures which were presented over a period of two and one-half weeks. The programmed text group scored significantly ($p < .05$) higher on the posttest than the lecture group. When posttest performance was regressed on pretest performance for each treatment group, the regression coefficients for the programmed text group and the lecture group were respectively .370 and 2.987. An analysis revealed that these coefficients were significantly ($p < .01$) different. This interaction is displayed in Figure 1.

Insert Figure 1 about here

Austin and Gilbert (1973) assigned sixty-six college students enrolled in a course on electricity and magnetism to either a Keller plan designed section or a regular lecture-recitation section. Courses designed according to the Keller plan are divided into units. As soon as a student passes a unit test, he/she is allowed to advance to the next unit. Of course, students in lecture-recitation courses all advance at the same rate. Keller plan students did 10-20% better on a final course examination than lecture-recitation students. Posttest performance for each course section was regressed on final exam performance of an introductory physics course which all the students previously had been required to complete. Although no interaction statistics were reported, the figure representing the regression lines suggested that the Keller plan was especially beneficial for low ability students. A modified version of this figure is shown in Figure 2.

Insert Figure 2 about here

Ott and Macklin (1975) compared audio-tutorial with lecture-recitation sections of an introductory physics course. Two-hundred and eighty-two students were involved. Most of them were male freshmen majoring in Engineering. In the audio-tutorial sections, students paced themselves through a study guide, self-demonstrations, and audio-tape commentaries with slides. In the lecture-recitation sections, students attended a lecture twice a week and a lab every other week. Course grades for the two types of sections did not significantly differ.

But, there was evidence of an interaction between abilities measured by a math pretest and by the mathematics portion of the Scholastic Aptitude Test and the treatment. The regression equations for the two treatments were as follows (X is the score on the math pretest, Y is the level on SATM, Z and U are estimated grades in the audio-tutorial and lecture-recitation treatments, respectively):

$$\text{Audio-tutorial} \quad Z = 9.1667 - .5175\, X_1 + .2633\, Y_2$$

$$\text{Lecture-recitation} \quad U = 10.6352 - .8495\, X_2 + .4081\, Y_2$$

Note that the coefficients X_1 and X_2 were negative because grades were coded from high to low while pretests were coded from low to high. With the level of significance set at .10, the Johnson-Neyman technique was applied to establish regions of significance. It was found that the lecture-recitation treatment was preferable to the audio-tutorial treatment for students with math pretest scores equal to nine and SATM scores greater than 725. The audio-tutorial treatment was preferable to the lecture-recitation treatment for students with math pretest scores less than four and SATM scores less than 625.

Nordland, Kahle, Randak, and Watts (1975) also compared individualized audio-tutorial with group lecture instruction. One-hundred and eighteen high school students enrolled in a biology class were randomly assigned to the two treatments. The experimental period lasted for three weeks. During that time, a series of four tests covering the instructional material were administered. No significant differences in test performance between the two treatment groups were observed. However, a number of standardized ability measures correlated more closely with the average test performance of students in the lecture treatment than with the average test performance of students in the audio-tutorial treatment as shown in Figure 3.

Insert Figure 3 about here

Stukat (1965) measured the posttest performance of 345 sixth grade Swedish students who were taught Swedish grammar by either programmed or conventional instruction. The programmed instruction was self-paced while the conventional instruction was not. The posttest means of the two treatment groups were almost the same. But when student posttest scores in each treatment group were split into high, medium, and low ability categories on the basis of scores on an unspecified intelligence test, an apparent treatment X ability interaction was noticeable. This interaction is shown in Figure 4.

Insert Figure 4 about here

Less able students seemed to benefit most from programmed instruction while more able students performed equally well with either type of instruction. Unfortunately, no statistical test of the significance of this interaction was reported.

Steeper Slopes Produced By Greater Learner Control

Cavanagh, Thornton, and Morgan (1965) administered the Birkbeck Intelligence Test to 158 British European Airways employees. Some of these employees then were supplied with a self-paced auto-tutorial lesson on how to regulate and distribute the weight an aircraft carries after considering a multitude of variables such as route, weather, and type of plane. Other employees were presented the same lesson in the form of an hour long lecture. No appreciable difference was detected between the mean posttest scores of the two treatment groups. However, the

correlation coefficients between the posttest and intelligence test scores in the auto-tutorial group and in the lecture group were respectively .68 and .27. The large difference between these correlations is indicative of a learner control X ability interaction.

Silberman, Melaragno, Coulson, and Estavan (1961) gave the Henmon-Nelson Test of Mental Ability to fifty-one high school students who then were randomly assigned to one of three treatments. All three treatments allowed students to pace themselves as they studied a lesson on some topics in logic consisting of sixty-one instructional displays. Students in the fixed treatment were not permitted to review displays they already had studied while students in the back branching treatment were given this option. Both fixed and back branching students were required to respond overtly to the question on each display before being able to advance to the next display. But, students in the textbook treatment did not have to satisfy this requirement. They were allowed to go to any display as soon and as often as they pleased. Posttest performance of the textbook treatment group was superior ($p < .05$) to that of the other two treatment groups. Furthermore, a learner control X ability interaction was suggested because the relationship between ability and posttest performance was especially pronounced in the textbook treatment group. The correlation coefficients between ability and posttest scores for the fixed, back branching, and textbook treatments were .45, .39, and .69, respectively.

Interactions of Learner Control and Locus of Control

Now we will turn our attention to interactions between learner control of presentation characteristics and student locus of control as measured by the Rotter I-E Scale. Persons who score low on the I-E scale are said to have internal locus of control and are thought to attribute

events in their lives to their own decisions and actions. On the other hand, persons who score high on the I-E scale are considered to possess external locus of control and supposedly attribute events in their lives to outside forces or luck. Because internally-oriented students tend to see themselves as being responsible for their learning, they probably prefer to make their own instructional decisions and are careful in making those decisions. However, because externally-oriented students tend to regard external factors as being responsible for their learning, they probably prefer to let teachers and systems make instructional decisions and, should such decisions be forced on them, they are not likely to exercise much care in making their choices. Therefore, greater learner control should facilitate learning for internally-oriented students while lesser learner control should facilitate learning for externally-oriented students. This hypothesized pattern of interaction was observed in the three studies that we will examine next.

Parent, Forward, Canter, and Mohling (1975) randomly assigned fifty-four college students to two treatments in which they received a two-hour mini-course on computer programming. In the high discipline treatment, the teacher laid down class rules and lectured. Thus, the sequence and pace of the instruction were controlled by the teacher. In the low discipline treatment, each student was given an instructional booklet and told to study it as he/she desired. The teacher merely answered questions. Neither treatment nor locus of control produced significant main effects in posttest performance. But, when the post-test scores of students from the upper-and lower-third of the locus of control distribution were analyzed, a significant ($p < .05$) treatment X locus of control interaction was obtained. It is represented in Figure 5.

Insert Figure 5 about here

Daniels and Stevens (1976) divided one-hundred and forty-six college students enrolled in an introductory psychology class into two groups on the basis of their responses to the Rotter I-E Scale. Both of these groups of students then were randomly assigned to two treatments. Students in the traditional treatment were required to attend all lectures, study the assigned readings, and take a weekly test. Students in the self directed treatment were asked to complete a contract for grade form in which they specified what areas they would focus on in their study and what projects they would undertake in each of the chosen areas of study. Lecture attendance and taking weekly tests was optional. A posttest was administered after eight weeks. Only those students scoring in the upper and lower 27% of the I-E scale were used in the data analysis. Main effects again were nonsignificant. Yet, the interaction between treatment and locus of control was highly significant ($p < .001$). This interaction is graphically portrayed in Figure 6.

Insert Figure 6 about here

Allen and Harshbarger (1977) arranged for a reading improvement course with eighty-five students to be taught in two fashions. Students enrolled in the student-controlled section were given a guide booklet which described areas of emphasis and use of available reading materials and machines. Each of these students met in a weekly conference with the teacher and wrote a contract listing the activities he/she planned to accomplish. Students enrolled in the teacher-directed section also were

provided with the guide booklet and participated in weekly individual conferences with the teacher. But, the teacher designated the activities each student was to engage in based on a diagnosis of that student's needs. All of the students were pre- and post-tested for reading achievement using two forms of the Diagnostic Reading Tests by Trigs. Pairwise comparisons of the means of the reading gain scores were performed for low and high scorers on the Rotter I-E Scale in each course section. The mean reading gain score of internally-oriented students in the student-controlled section was significantly ($p < .05$) higher than that of internally-oriented students in the teacher-controlled section. All other pairwise comparisons were nonsignificant.

Interactions of Learner Control and Personality Characteristics Other Than Locus of Control

Of course, student locus of control is not the only personality characteristic that may interact with learner control of presentation characteristics. We will now look at four studies which investigated the interaction of learner control and personality characteristics other than locus of control.

Dowaliby and Schumer (1973) administered the Taylor Manifest Anxiety Scale to sixty-nine college students in two sections of an introductory psychology course. The course sections were arbitrarily designated as teacher centered or student centered. In the teacher centered section, a lecture format was followed which discouraged student initiated questions and responses. In the student centered section, a discussion format was employed which encouraged student initiated questions and responses. Two unit exams were used as the dependent measures. No significant difference between the course sections was found for either exam. But, tests for parallel slopes revealed a

significant treatment X anxiety interaction for the exam on basic conditioning ($p < .01$) and for the exam on psychological measurement ($p < .05$). Figure 7 presents these interactions.

Insert Figure 7 about here

In both cases the more anxious students performed best in the teacher centered section while the less anxious students performed best in the student centered section.

Smith, Wood, Downer, and Rayor (1950) gave a questionnaire derived from Cattell's Sixteen Personality Factor Test to 225 college students who were registered for a seven week reading improvement course. Responses to the questionnaire were used to identify sixty-nine anxious students who exhibited either high or low permeability. High permeability anxious persons were described as being flexible, disorganized, dependent, and imaginative. Low permeability anxious persons were described as being rigid in attitudes, aggressively independent, and suspicious. The anxious high and low permeability students were randomly assigned to directive or nondirective sections of the course. In directive sections, attendance was mandatory, lectures addressed a series of predetermined topics, and the teacher made exercise assignments. In nondirective sections, attendance was voluntary, discussions centered on what students thought was interesting, and students decided what exercises, if any, they would complete. Rate of reading comprehension was assessed by two forms of the Diagnostic Reading Test. One form was taken at the beginning of the course and the other at the end of the course. Gain scores expressed in terms of percentage increase over initial rate of comprehension were used as the dependent variable. The

means of the gain scores for high and low permeability students in each type of section are graphically displayed in Figure 8.

Insert Figure 8 about here

The difference between the means within each personality type was significant ($p < .01$).

Domino (1971) obtained the California Personality Inventory achievement via conformance (Ac) and achievement via independence (Ai) subscale scores for each student enrolled in a college introductory psychology course. The top fifty low Ac-high Ai and the top fifty high Ac-low Ai students were randomly assigned to two kinds of course sections. In conformance sections, attendance of the lectures was required, grades were based on exam scores, and homework was assigned by the teacher. In independent sections, attendance of the small group discussions was not required, grades were decided upon in consultation with the teacher, and no homework was assigned. At the end of the semester, all students took a posttest consisting of multiple-choice and essay questions. The responses to the essay questions were rated according to factual knowledge and original thinking. Achievement orientation interacted significantly ($p < .05$) with treatment for both score on multiple-choice questions and factual knowledge rating of the essay questions. Figure 9 depicts these interactions.

Insert Figure 9 about here

Pascarella (1977) randomly selected forty-seven college students from each of two sections of an introductory calculus course. One of the

sections was taught in accordance with the Keller plan of personalized instruction which allows students to pace themselves. The other section consisted of conventional lecture and question-answer sessions. At the beginning of the semester, the experimental students were administered the Mathematics Placement Test (MPT) and Murray's Activities Index (AI). Both the experimental students in the Keller plan section and those in the conventional section scored about the same on all parts of these tests. One part of the AI is called the motivation scale. It is thought to measure a person's inclination to set difficult goals for him/herself, concentrate during study, and persevere in working on problems. A multiple regression analysis was performed. The model for this analysis used score on a final course exam as the dependent term, score on the MPE as the first predictor, score on the AI motivation scale as the second predictor, indicator of section type (Keller plan or conventional) as the third predictor, and interaction of AI motivation score and section indicator as the last predictor. All of these predictors were significant ($p < .05$). The type of section X motivation interaction is represented in Figure 10.

Insert Figure 10 about here

Conclusion

If learner control of certain presentation characteristics interacted with certain learner characteristics as the findings of these studies suggest, then learner control of presentation characteristics would not be a panacea for accomodating individual differences. Instead, some kinds of individual differences probably should be taken into account by teachers and instructional systems as they decide what learner

control of presentation characteristics students are given.

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Figure Captions

Figure 1. Treatment X pretest score interaction in Roebuck (1970) experiment.

Figure 2. Treatment X previous course exam score interaction in Austin and Gilbert (1973) experiment.

Figure 3. Correlations between test performance and various standardized ability measures for each treatment in Nordland, Kahle, Randak, and Watts (1975) experiment.

Figure 4. Treatment X ability interaction in Stukat (1965) experiment.

Figure 5. Treatment X locus of control interaction in Parent, Forward, Canter, and Mohling (1975) experiment.

Figure 6. Treatment X locus of control interaction in Daniels and Stevens (1976) experiment.

Figure 7. Treatment X anxiety interaction for basic conditioning exam and for psychological measurement exam in Dowaliby and Schumer (1973) experiment.

Figure 8. Treatment X permeability interaction in Smith, Wood, Downer, and Rayor (1956) experiment.

Figure 9. Treatment X achievement orientation interaction for multiple choice score and for factual knowledge rating in Domino (1971) experiment.

Figure 10. Treatment X motivation interaction in Pascarella (1977) experiment.

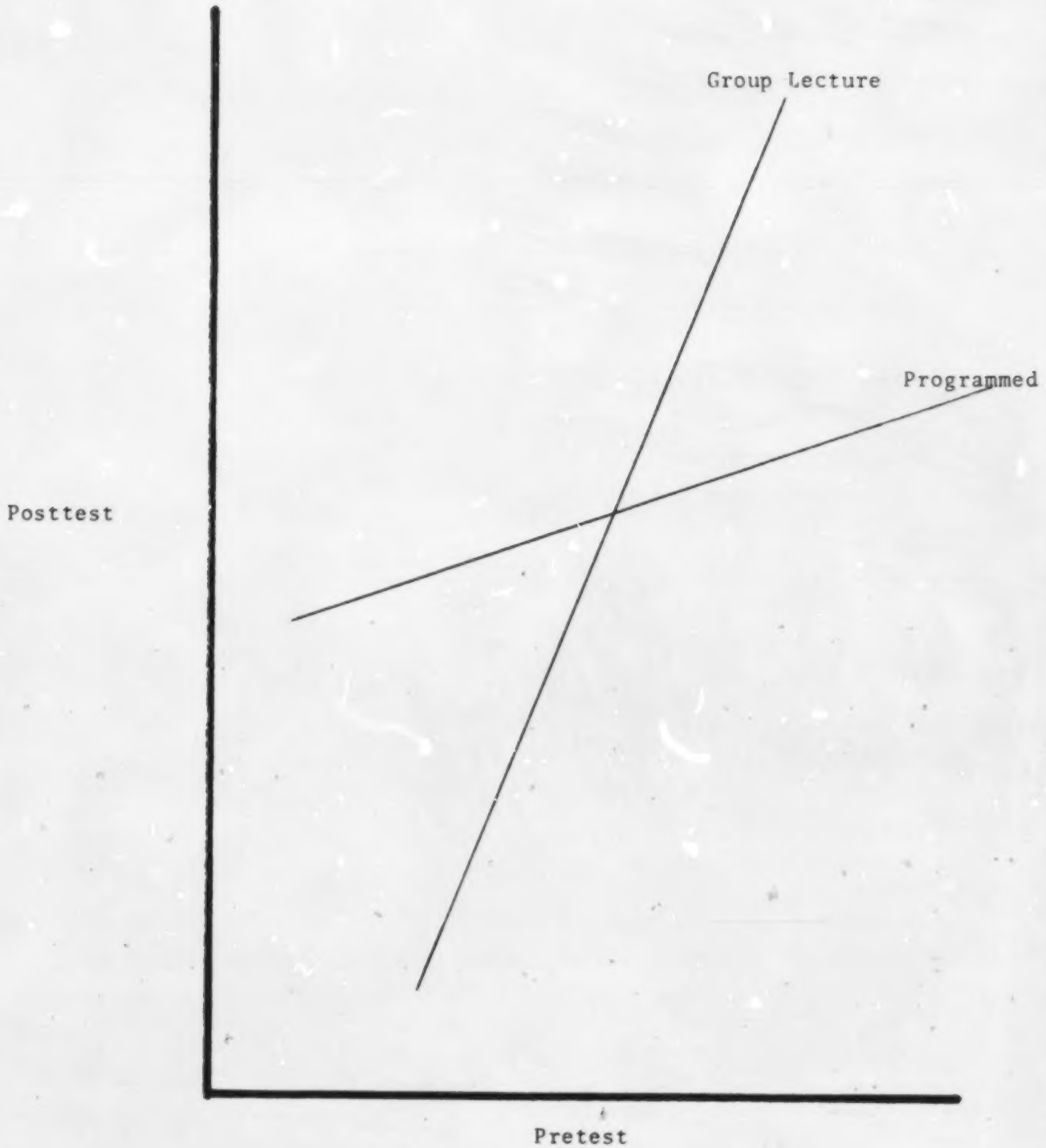


Figure 1

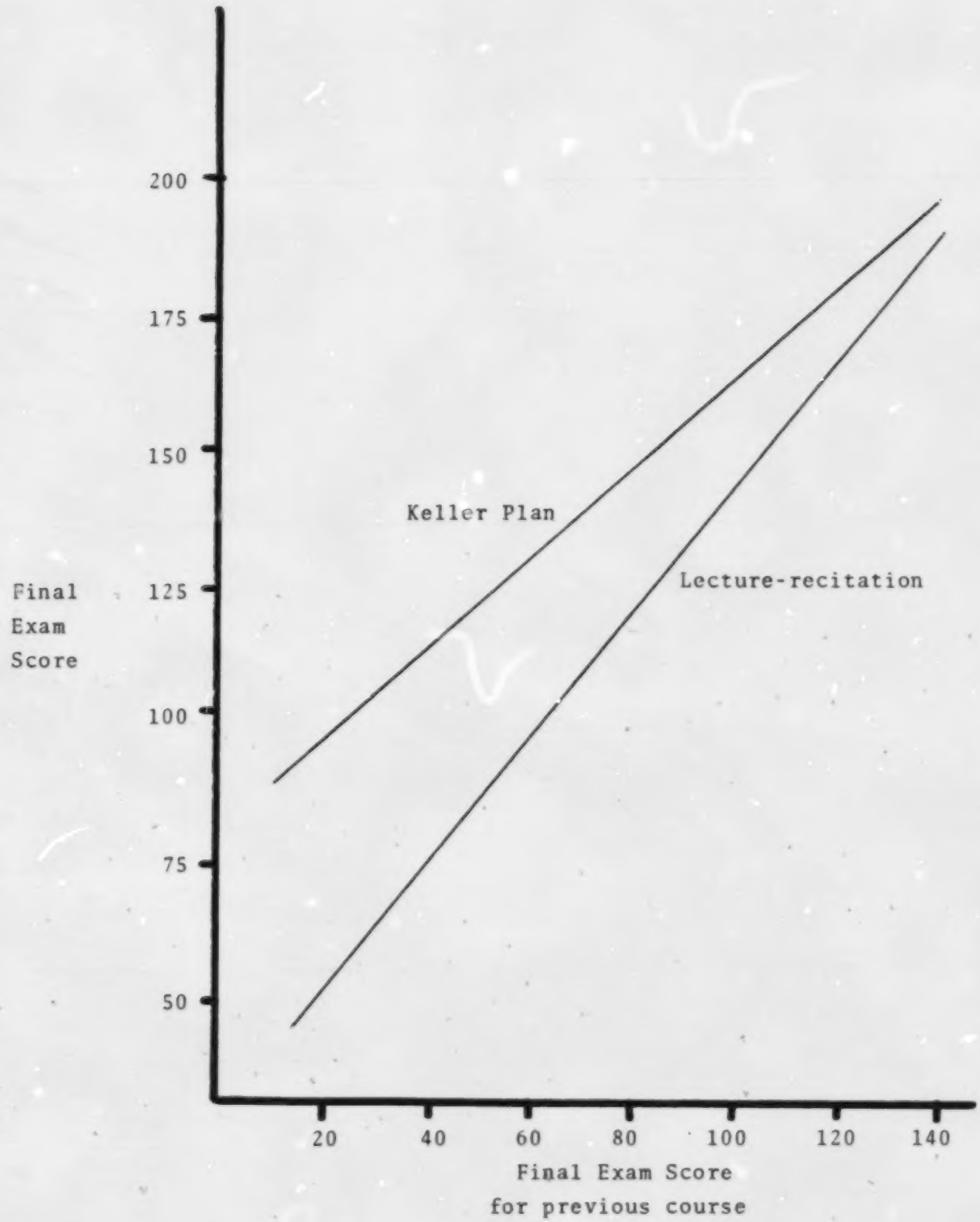

200
175
150
125
100
75
50
Final
Exam
Score
Keller Plan
Lecture-recitation
20
40
60
80
100
120
140
Final Exam Score
for previous course

Figure 2

Predictor Variable	r value Audio-tutorial	Group-lecture	Fisher z Statistic
SCAT Quant.	.40	.58	1.24
SCAT Verbal	.09	.47	2.15*
SCAT Total	.29	.60	2.08*
Otis IQ	-.08	.27	2.30*
STEP Reading	.02	.39	2.04*
SAT Science	.11	.44	2.37*
SAT Language	-.13	.48	3.88**
SAT Arith. Comp.	.08	.55	3.54**
SAT Arith. App.	.13	.59	3.65**
SAT Para. Meaning	-.19	.37	3.14**

Figure 3

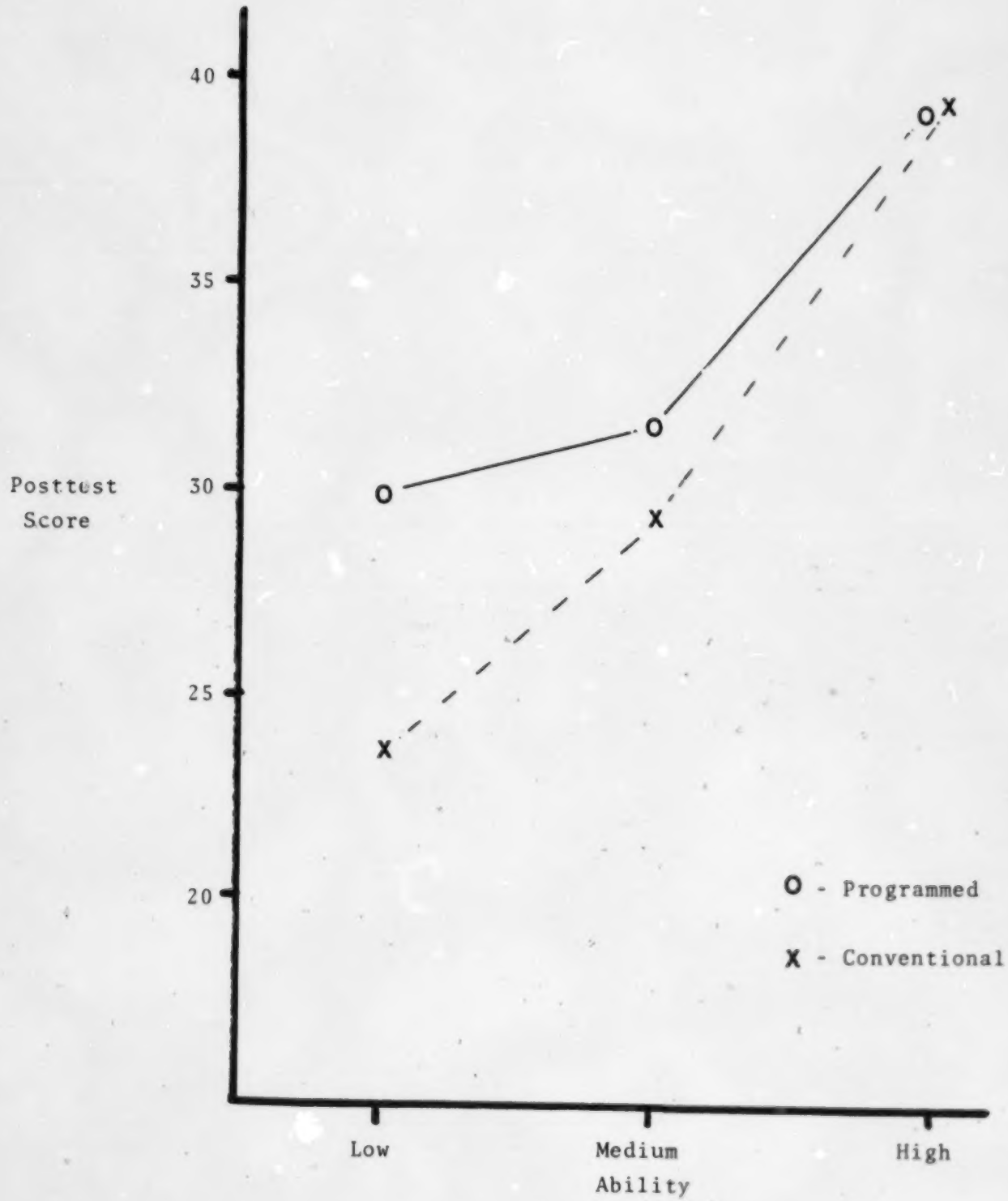

40
35
30
25
20
Posttest Score
O
O
O X
X
X
O - Programmed
X - Conventional
Low
Medium Ability
High

Figure 4

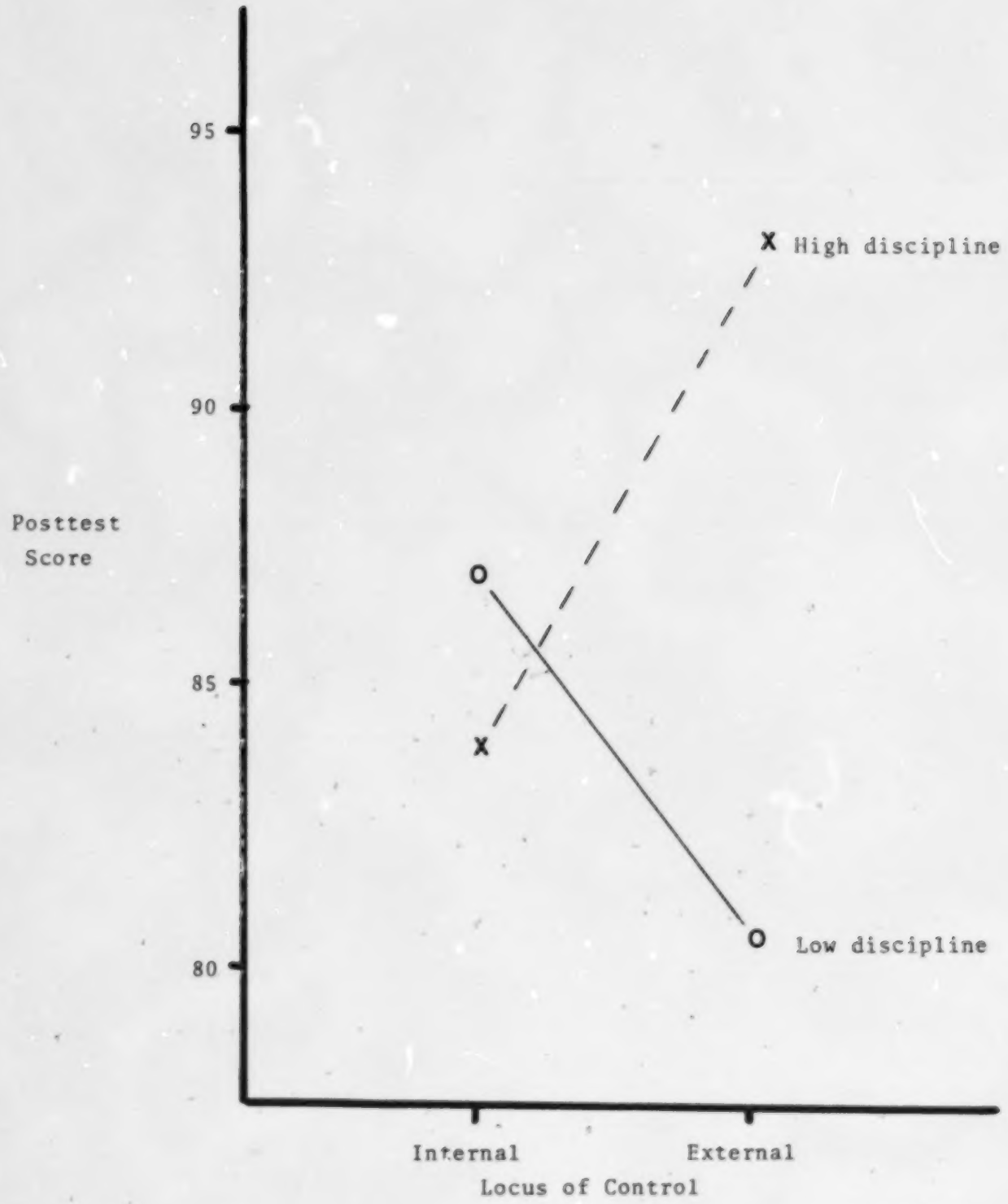

95
90
85
80
Posttest
Score
X High discipline
O
X
O Low discipline
Internal
External
Locus of Control

Figure 5

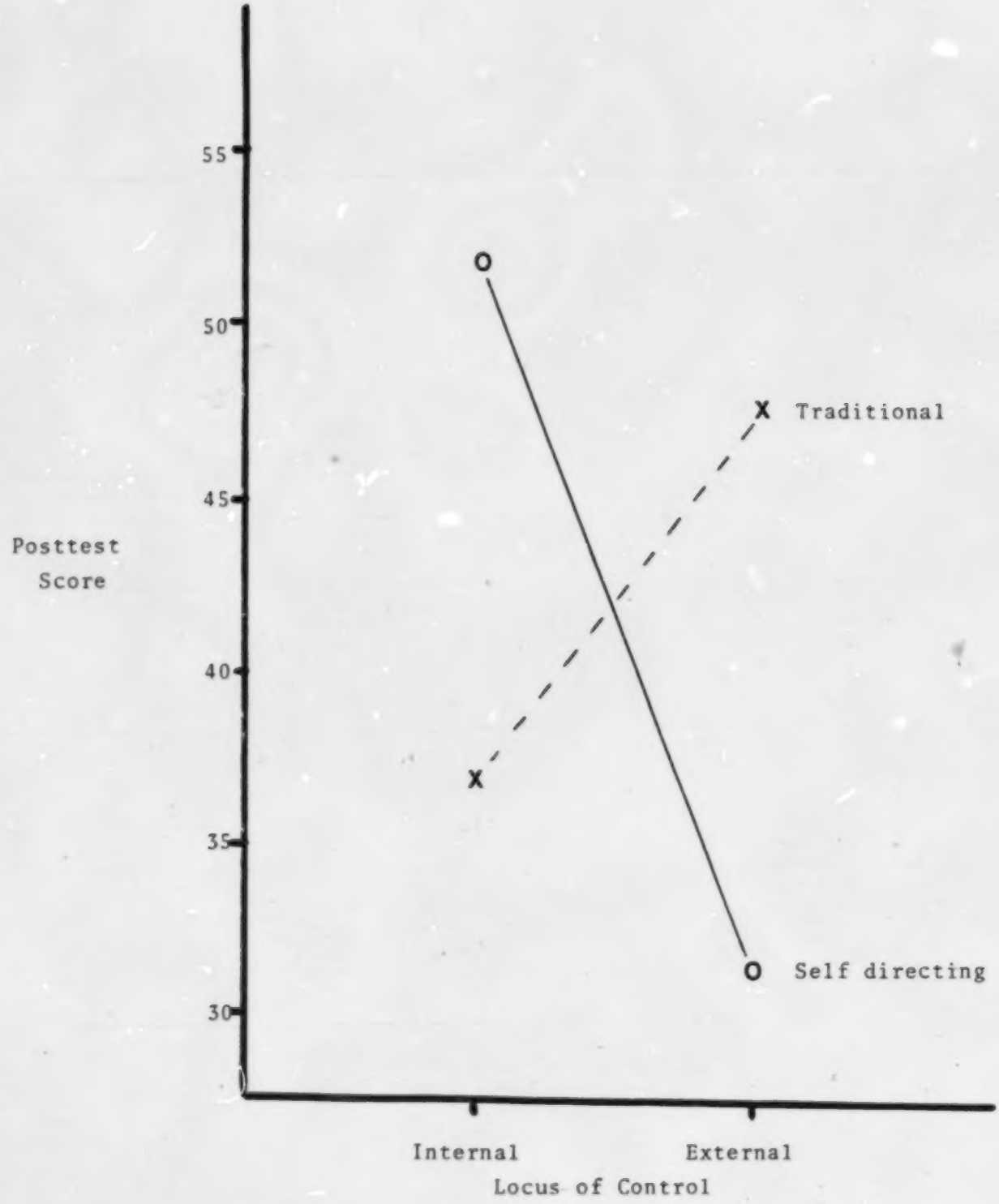
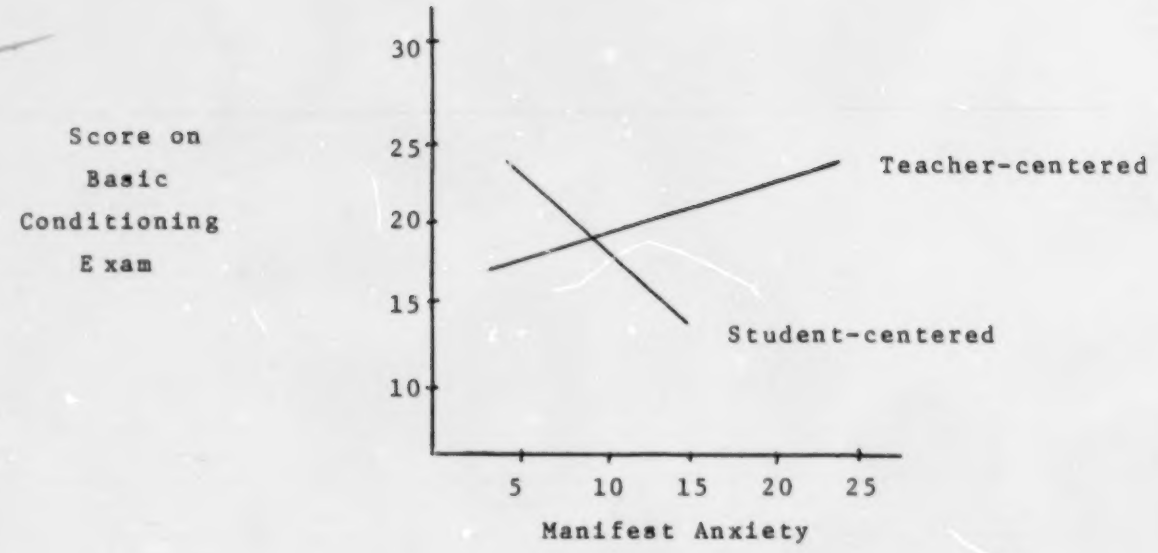

55
50
45
40
35
30
Posttest Score
X Traditional
O Self directing
Internal
External
Locus of Control

Figure 6


Score on
Basic
Conditioning
Exam
30
25
20
15
10
Teacher-centered
Student-centered
5
10
15
20
25
Manifest Anxiety

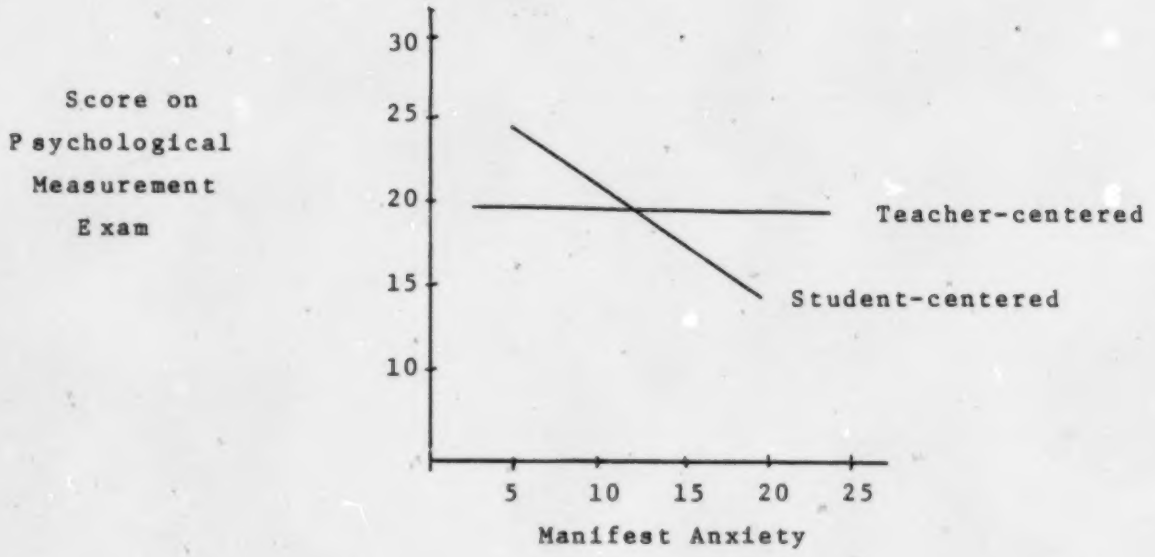

Score on
Psychological
Measurement
Exam
30
25
20
15
10
Teacher-centered
Student-centered
5
10
15
20
25
Manifest Anxiety

Figure 7

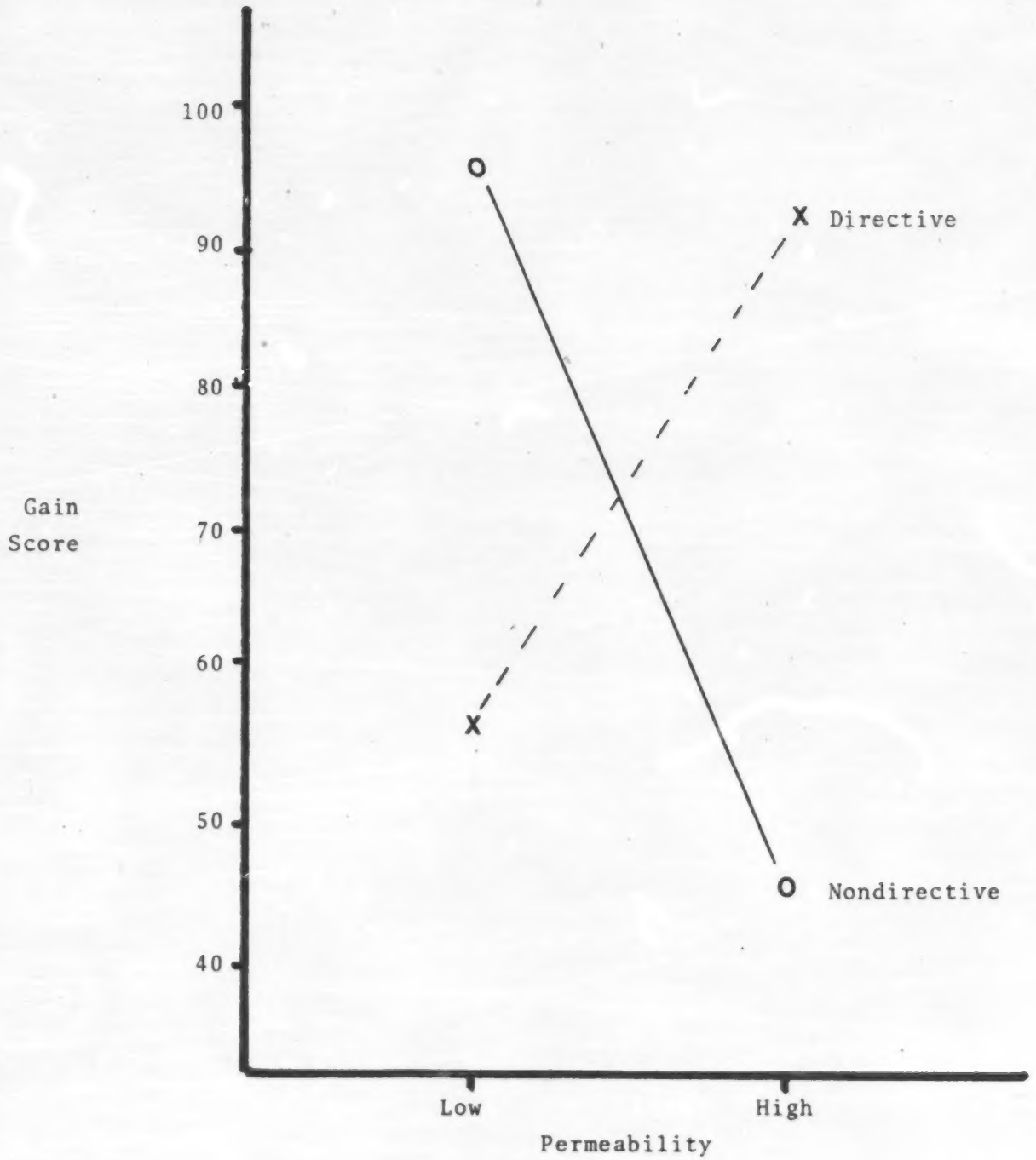
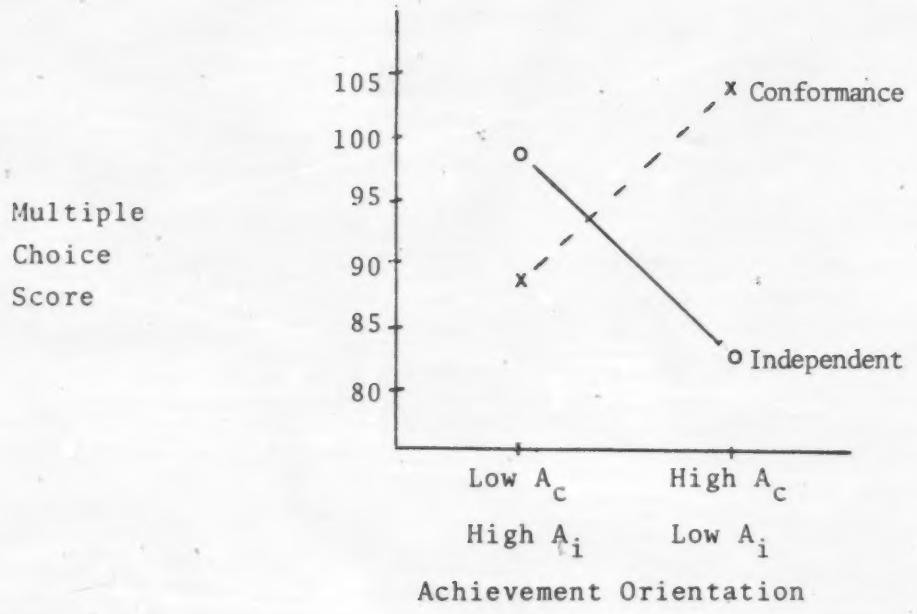

100
90
80
70
60
50
40
Gain
Score
X Directive
O
X
O Nondirective
Low
High
Permeability

Figure 8


Multiple
Choice
Score
105
100
95
90
85
80
x Conformance
o Independent
Low A_c
High A_i
High A_c
Low A_i
Achievement Orientation

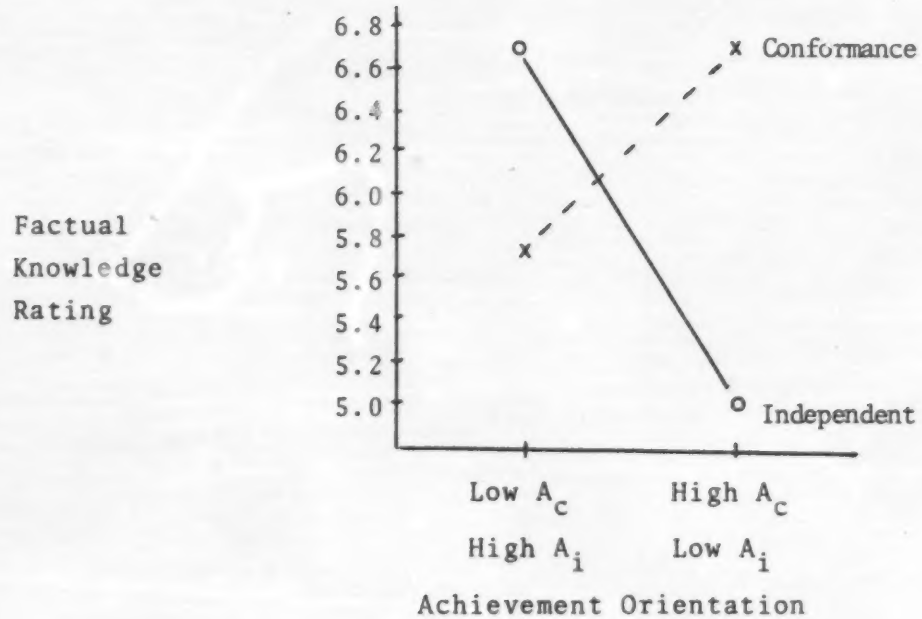

Factual
Knowledge
Rating
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
x Conformance
o Independent
Low A_c
High A_i
High A_c
Low A_i
Achievement Orientation

Figure 9

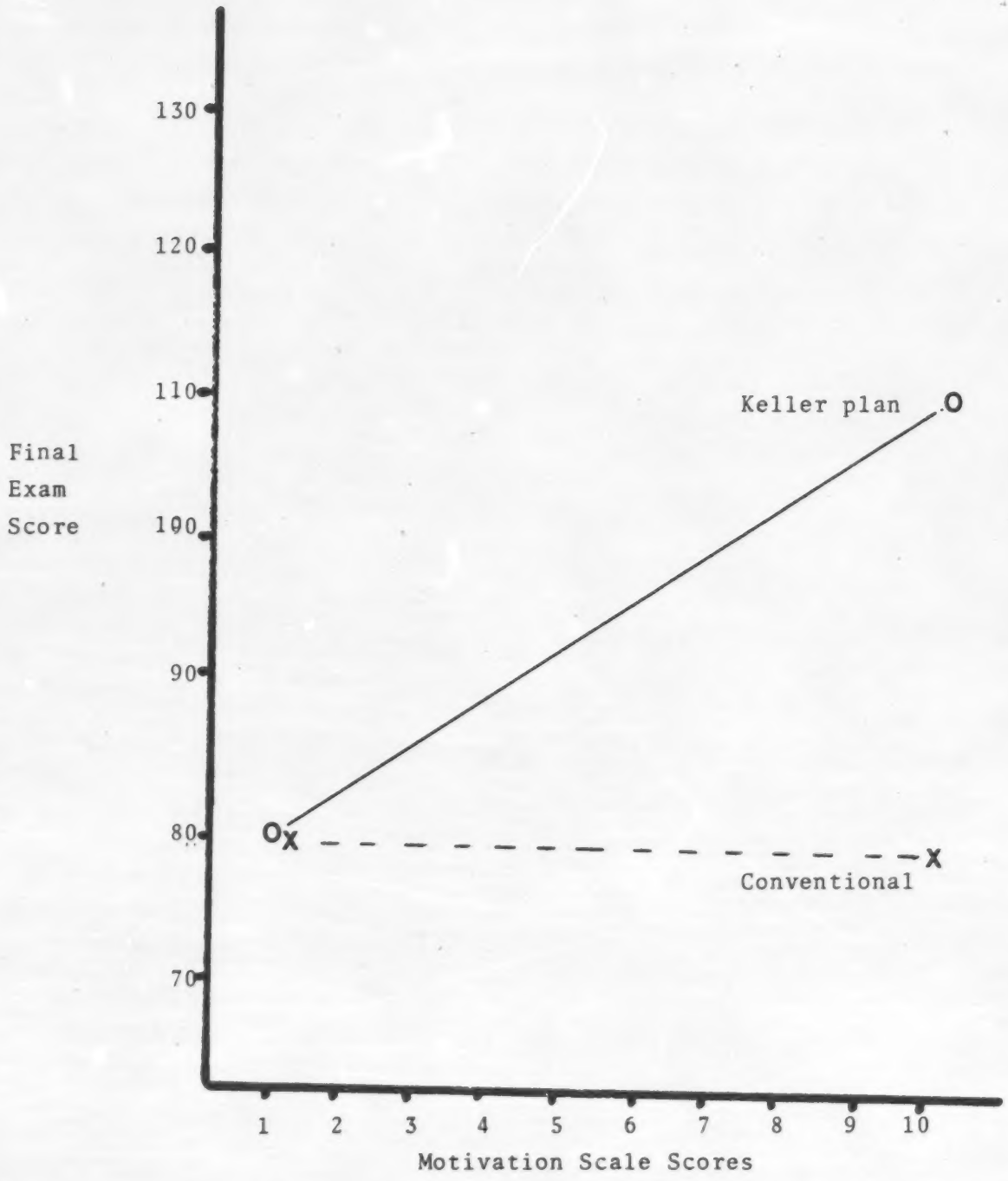

130
120
110
100
90
80
70
Final
Exam
Score
Keller plan
O
X
Conventional
1
2
3
4
5
6
7
8
9
10
Motivation Scale Scores

Figure 10